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Three New Turonian Muricacean Gastropods from the Santa Ana Mountains, Southern California

by

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Abstract. Three new species of *Praesargana, P.* ***argentea****, P.* ***confraga****,* and *P.* ***kennedyi****,* are the first sarganines reported from southern California. These rare muricacean gastropods of late Turonian age occur in the Baker Canyon Sandstone Member and the overlying lower part of the Holz Shale Member of the Ladd Formation in the Santa Ana Mountains, Orange County, California. Inclusion of *P.* ***argentea*** and *P.* ***kennedyi*** in *Praesargana* broadens the concept of the genus to include species that have spiny sculpture, and species that lack a strong axial component to the sculpture. One species of *Praesargana, P. condoni* (White, 1889), was previously known from the Turonian of northern California. This threefold increase in diversity in a more southern fauna suggests that *Praesargana* may be indicative of a warm-temperate to tropical climate. Sarganinae resemble predaceous Muricidae rather than ciliary-feeding Trichotropidae, but have a fold on the columella and a protoconch more like that of Pyropsinae. For these reasons, despite recent assignments to other families, Sarganinae are included in the family Tudiclidae of the Muricacea.

INTRODUCTION

Although gastropods of Cretaceous age from the Santa Ana Mountains, Orange County, California, have been described in several papers (e.g., Packard, 1992; Popenoe, 1937; Saul & Popenoe, 1993), the faunas are incompletely known. This paper describes three new muricacean species of late Turonian age from the Baker Canyon Sandstone Member and the overlying lower part of the Holz Shale Member of the Ladd Formation. Figure 1 plots the localities at which these species have been found on a geologic map.

At least 38 other molluscan taxa are present at the 10 localities that yielded these new species (Table 1). The ammonite *Subprionocyclus* sp. indicates a late Turonian age for these deposits (Matsumoto, 1959, 1960). Most of these fossiliferous beds may be storm deposits, but, at USGS loc. 2759, specimens of *Anchura (Helicaulax) tricosa* Saul & Popenoe, 1993, with elongate outer lip and rostral extensions preserved, suggest that these shells could not have undergone much transport or reworking by wave action. Saul (1982) considered the mollusks of these assemblages to have lived from the sublittoral to depths not greater than 40 m. At LACMIP 16644 the impression of a fragment (roughly 2 cm × 0.7 cm) of a coral colony was found. About 35 calices are present on the fragment, which possibly used a gastropod shell as substrate. Corals are rare in Pacific Slope Late Cretaceous deposits, and colonial corals even rarer. If this was a hermatypic coral, it suggests clear, normal salinity water above 18°C at a site of low sedimentation in water less than 50 m deep (Wells, 1956: F353). If the specimen was not transported downslope, it suggests a probable depth limit for these faunas.

These three new species have apertural features characteristic of the Late Cretaceous muricacean subfamily Sarganinae Stephenson, 1923. At present the subfamily comprises only *Sargana* Stephenson 1923, and *Praesargana* Saul & Popenoe, 1993, and each genus contains but few species. Additionally, *Rapana tuberculosa* Stoliczka, 1867, from near Serdamungalum, southern India may be a sarganine. In the illustrations and description of *R. tuberculosa* from the Trichinopoly Group of Turonian-Coniacian age (Acharyya & Lahiri, 1991), the description of the very narrow anterior siphonal canal is especially suggestive of Sarganinae. According to Stoliczka (1867:156), the description of this species was prepared before the specimen accidentally fell into acid, and the illustration was drawn after the spines had been partially etched away. Petuch (1988:12) has suggested that *Ecphora proquadricostata* Wade, 1917, should be placed in an as yet unnamed sub-

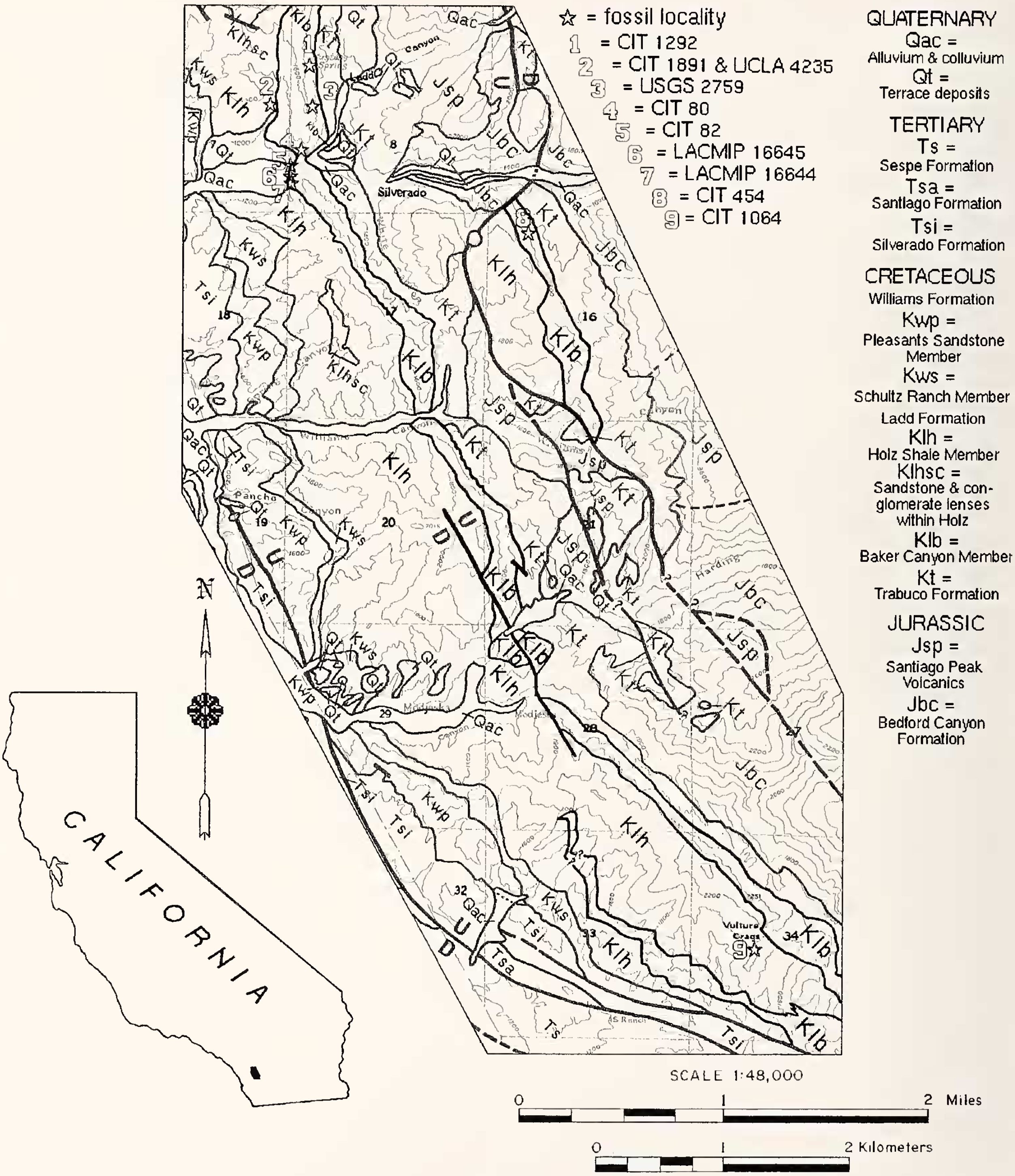


Figure 1

Geologic map of a portion of the northern Santa Ana Mountains, Orange County (after Morton, Miller, and Fife, 1973), with localities yielding specimens of *Praesargana* species. Map includes parts of Black Star Canyon (1967), Corona South (1967), El Toro (1968), and Santiago Peak (1954) USGS 7 ½-minute quadrangles.

Table 1

List of species associated with three *Praesargana* n. sp. Localities yielding *Praesargana* spp. are listed left to right in ascending stratigraphic order and toward deeper water deposits. Of the three species, *P.* ***kennedyi*** seems to have lived on shallowest bottoms and nearest to shore. *Praesargana* ***argentea*** and *P.* ***confraga*** are both associated with *Anchura (H?) tricosa* in moderate depth shelfal assemblages that include ammonites. (See Saul, 1982, for listings of shallower and deeper water Santa Ana Mountains Cretaceous faunas).

Biota associated with *Praesargana* spp.	Map Number Locality number	1 1292	4 80	3 2759	5 82	2 4235	2 1891	8 454	7 16644	6 16645	9 1064	
Trigonarca californica Packard, 1922		■	■			□	□					B
Pinna calamitoides Shumard, 1859		□						□				B
Lima beta Popenoe, 1937		□	▲		■		▲					B
Alleinacin sulcata (Packard, 1922)		▲				□						B
Ambocardia delta (Popenoe, 1937)		□			□		□					B
Callistalox arata (Gabb, 1864)		□	□		□							B
"*Aporrhais*" *vetus* Packard, 1922		□		□								G
Ampullina pseudoalveata (Packard, 1922)		□	□		□	□	□	□			?	G
Gyrodes dowelli White, 1859		□				□						G
Praesargana ***kennedyi*****,** sp. nov.		★	★				★					G
Varens formosus Saul & Popenoe, 1993		□	□		□			□				G
Glycymeris pacificus (Anderson, 1902)			■		□		▲				□	B
Pterotrigonia klamathonia (Anderson, 1958)			□		▲	□	□					B
Crassatella gamma Popenoe, 1937			□								■	B
Paraesa? zeta (Popenoe, 1937)			▲									B
Liopistha anaana (Anderson, 1902)			■									B
Latiala nodosa (Packard, 1922)			□		▲	□	□	□				G
Anchura (Helicaulax) tricosa Saul & Popenoe, 1993				▲	▲	■	□	▲	■	■	□	G
Praesargana ***argentea*****,** sp. nov.				★		★			★	★		G
Cucullaea (Idonearca) gravida (Gabb, 1864)					■	□		■			■	B
Tenea inflata (Gabb, 1864) small var.					▲	▲						B
Corbula sp.					□	□		□				B
Turritella hearni Merriam, 1941					▲	?						G
Varens anae Saul & Popenoe, 1993					□							G
Praesargana ***confraga*****,** sp. nov.					★			★			★	G
pycnodontid						▲			▲	▲		B
Pachycardium coronaense (Packard, 1922)						□	□				■	B
Calva regina Popenoe, 1937						□				□		B
?*Atira* sp.						□	□					G
Sciponoceras sp.						☆						C
Subprionocyclus sp.						☆			☆	☆		C
Inoceramus sp.							□					B
Neophylloceras sp.							☆					C
Cyprimeria moorei Popenoe, 1937								□				B
Aporrhais n. sp.								□			□	G
Carota dilleri (White, 1889)								□				G
Biplica cf. *B. isoplicata* Popenoe, 1957								□				G
Ellipsoscapha ? sp.								□				G
Eutrephoceras sp.								□				C
pachydiscid ammonite								☆				C
colonial coral									□			
Indogrammatodon sp.											□	B
Turritella iota Popenoe, 1937											□	G
Arrhoges sp. nov.											□	G

■ = abundant; ▲ = common; □ = rare; ★ = *Praesargana* spp., all are rare; ☆ = ammonite, all are rare; B = Bivalvia; C = Cephalopoda; G = Gastropoda.

genus of *Sargana,* but *E. proquadricostata* has an internally denticulate outer lip and a moderately wide siphonal canal. It lacks a columellar fold and a posterior notch at the suture.

Sargana has been recorded from the Senonian of Pondoland, South Africa, and the Campanian–Maastrichtian of the Gulf and Atlantic Coasts of North America. *Praesargana* was previously known from *P. condoni* (White,

Table 2

Characteristics of Tudiclidae, Tudiclinae, Pyropsinae, and Sarganinae.

Tudiclidae	Tudiclinae	Pyropsinae	Sarganinae
Shell Shape and Size			
Rapiform or pyriform, small to large size, commonly with moderate to long anterior siphonal neck	Medium to large size, with moderate to long anterior siphonal neck	Medium to large size, with moderate to long, tapering anterior siphonal neck	Small to medium size, with short to moderately long anterior siphonal neck, bent back to left, forming wide to moderte umbilicus
Whorl Shape			
Angulate, biangulate, or rounded	Angulate or biangulate with abrupt basal constriction	Angulate to rounded, abruptly to smoothly constricted basally	Angulate or subangulate, abruptly to smoothly constricted basally
Anterior Canal			
Commonly long	Long and narrow, nearly straight	Moderate to long, more or less narrow, nearly straight	Short to moderately long, very narrow
Protoconch			
Paucispiral, low	Low to papillate in earlier species becoming bulbous in late species	Low to nearly flattened	Low to flat
Aperture			
Rounded, commonly nearly as wide as high, commonly subangulate at shoulder	Rounded, nearly as wide as high, inside of outer lip lirate or smooth	Rounded to elongate, expanded, commonly subangulate at shoulder	Rounded, nearly as wide as high, some with angulation at shoulder
Columellar Fold			
One fold or swelling at entrance to siphonal canal or no fold	One fold at entrance to siphonal canal; inner lip wraps over fold leaving umbilical chink	One fold or swelling at entrance to siphonal canal or no fold; inner lip wraps over fold or swelling leaving umbilical chink	One fold at entrance to siphonal canal opposite projecting tubercle on inside of outer lip

1889) of Turonian age in northern California; this paper adds three species from southern California for a tripling of diversity in the more southern fauna. This is the first record of a possible latitudinal species diversity gradient within a sarganine genus. *Praesargana* and *Sargana* occurred both north and south of the equator in warm-temperate to subtropical faunas, and they apparently were more specifically diverse nearer the equator. Presently the sparse geological record of this group suggests that the Sarganinae may be a tropical to warm-temperate group.

California also provides, at present, the geologically earliest record of the sarganines, although the possible Indian record may be nearly contemporaneous. The geologically latest records are from the Gulf Coast of North America. The record is too meager to support a sarganine origin in the eastern Pacific or a direction of migration.

Abbreviations used in this paper include CIT, California Institute of Technology (collections at LACMIP); LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology; UCLA, University of California, Los Angeles (collections at LACMIP); USGS, United States Geological Survey; USNM, United States National Museum.

SYSTEMATIC PALEONTOLOGY

Superfamily MURICACEA Rafinesque, 1815

Family Tudiclidae Cossmann, 1901

Confusions resulting from orthographic meddling with the name *Tudicla* Röding, 1798, and resultant spellings of Tudiclidae were resolved by Rosenberg & Petit (1987). Composition and characteristics of the Tudiclidae were discussed by Saul (1988). With the placement of Sarganinae in Tudiclidae (Saul, 1995), the family comprises Tudiclinae Cossmann, 1901, Pyropsinae Stephenson, 1941, and Sarganinae. Table 2 lists and contrasts some of the characteristics of these three named subfamilies. Only the Tudiclinae is represented in a modern fauna, and the soft part anatomy of the sole living species, *Tudicla spiralis* (Linnaeus, 1767), is unknown. Although these subfamilies have not previously all been assigned to a single family, their shells are sufficiently similar to be confamilial. The type species of *Tudicla, T. spirillus* (Linnaeus, 1767), from the Bay of Bengal has an internally lyrate outer lip and a large mammillate protoconch of one and a half round, swollen, glossy whorls. Protoconchs of geologically older species of *Tudicla* are, however, smaller and much less bulbous, as, for instance, is that of *Tudicla rusticula* (Basterot, 1825), a mid-Miocene species from the Vienna Basin of Austria. Protoconchs of Pyropsinae of Cretaceous and earliest Tertiary age consist of about one and a half round, smooth whorls, but they are smaller and lower than those of *Tudicla.*

Subfamily Sarganinae Stephenson, 1923

The family Sarganidae was erected by Stephenson (1923: 377) to include *Sargana* and an undescribed genus from the Ripley Formation of Georgia and Alabama later described by Wade (1926:177) as *Schizobasis.* Stephenson (1952:181) formally included *Schizobasis* Wade and *Hillites* Stephenson, 1952, in the Sarganidae, but Sohl (1964: 174) disassociated *Hillites* and *Schizobasis* from *Sargana* and placed them in the Moreinae Stephenson, 1941. In addition, Sohl (1964:174) considered *Sargana* sufficiently similar to *Rapana* Schumacher, 1817, and other Rapaninae Gray, 1853, to be included in that subfamily of the Muricidae. Ponder & Warén (1988:305) resurrected the subfamily Sarganinae and placed it with a query in the Muricidae. Garvie (1991) placed *Sargana* in Trichotropidae and then in Cancellariidae (Garvie 1992). Tracey et al. (1993) suggested that *Lowenstamia* Sohl, 1964, and *Sargana,* which they comment upon under Coralliophilidae Chenu, 1859, are possibly neotaenioglossan muricacean homeomorphs. Saul (in press) proposed including the Sarganinae in the Tudiclidae.

Stephenson (1952) distinguished Sarganidae from Muricidae on the basis of its flattened spire and the columellar fold, but Sohl (1964), in assigning *Sargana* to the Rapaninae, pointed out that some Muricidae (e.g., *Murex* Linnaeus, 1758) have a similar fold on the columella and that, "*Sargana* itself is muricid in the character of its ornament and its siphonal canal." The muricid genera *Antinotrophon* Dall, 1902, *Ecphora* Conrad, 1843, and *Rapana* "have similar umbilical characters" (Sohl, 1964). An open umbilicus formed by a revolving, strongly deflected anterior canal is also present in *Poirieria* Jousseaume, 1880, and *Paziella* Jousseaume, 1880, two muricine taxa recognized from the Cretaceous (Garvie, 1991, 1992). The openness of the umbilicus is greatly exaggerated in *Sargana,* however. This feature, in conjunction with the shape of its protoconch (Figure 2) and early whorls, suggests that *Sargana* and *Praesargana* be placed not in Rapaninae but in Sarganinae.

Although Garvie (1991) indicated that *Sargana* is a close relative of trichotropids in the Neotaenioglossa on the basis of the protoconch, other characteristics suggest that it is muricacean in its affinities. Overall shape of the Sarganinae is very similar to that of the predaceous muricids. Sarganines have a very well defined, elongate anterior siphonal canal and a well-marked, posterior notch (Figures 7, 10). Both features, although not confined to predators, are unknown among ciliary feeders such as the trichotropids. Late Cretaceous trichotropids are sufficiently similar to modern species to suggest that they had already evolved a mode of life comparable to that of modern species.

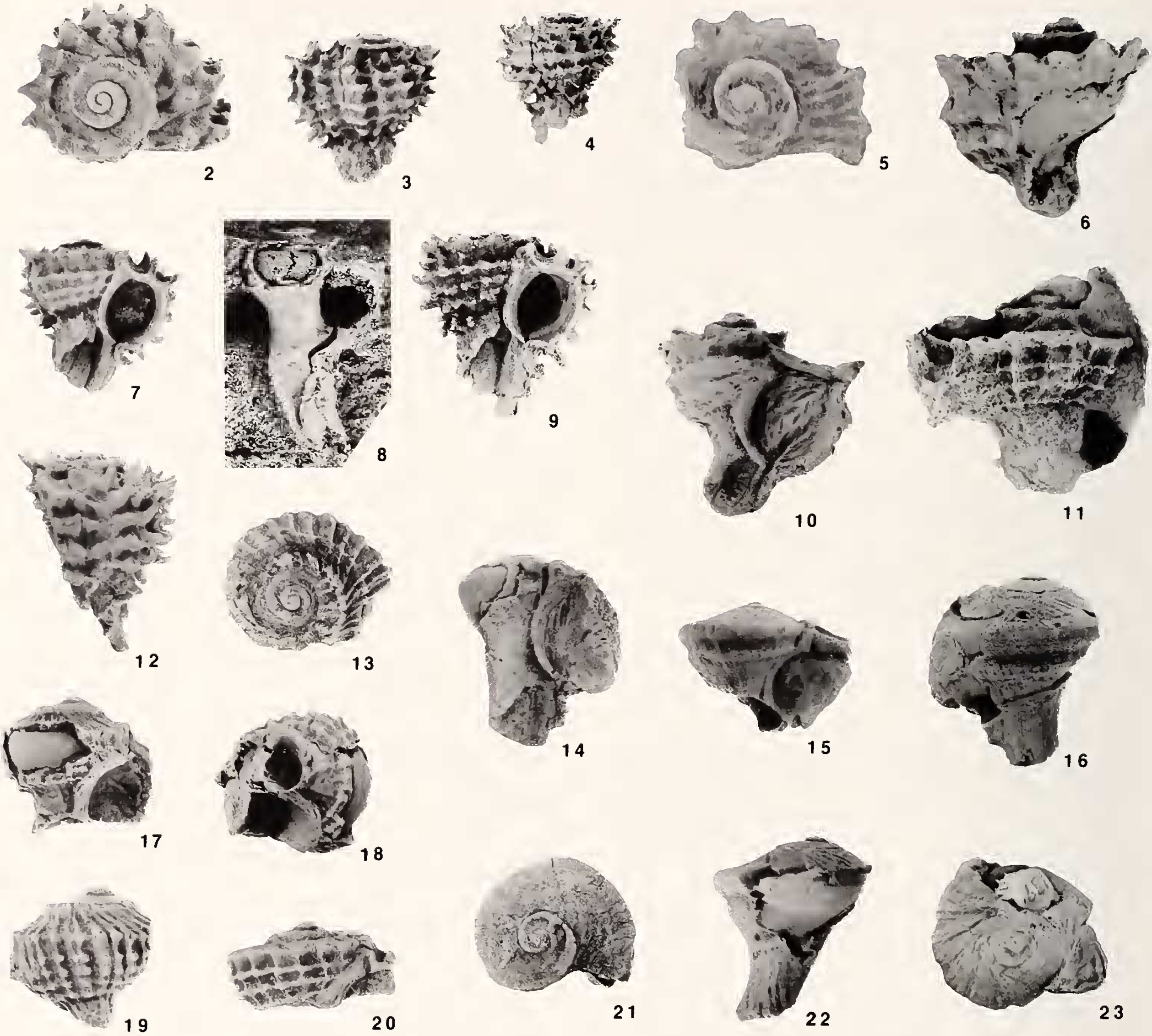
Garvie (1992) gave no reason for placing *Sargana* in the Cancellariidae. Shell shape, sculpture, and apertural features are sufficiently different that they can hardly have been the basis for this assignment, nor is the protoconch similar. For instance, the protoconch of *Cancellaria arnoldi* Dall, 1909, from the San Diego Formation of Pliocene age, San Diego, California, has more whorls and is higher than protoconchs of *Sargana* and *Praesargana,* and it lacks the carina present in sarganine protoconchs.

The protoconch of both *Sargana* and *Praesargana* is paucispiral, low, rapidly expanding, and becomes carinate after about one and a half whorls. In *Praesargana* the protoconch is slightly less flattened than in *Sargana.* In their paucispiral protoconchs, sarganines differ from the earliest representatives of most muricid groups in which multispiral protoconchs are present (Vokes, 1971). Whereas Muricinae and Rapaninae have multispiral protoconchs that probably indicate planktotrophic larvae (Kool, 1993b), the protoconchs of the Ocenebrinae, which appear slightly later in the geologic record, are paucispiral (Kool, 1993a, b). Kool (1993b) emphatically based his revision of the Rapaninae upon gross anatomy, radular, opercular, and protoconch morphology, and shell ultrastructure. He discussed placement of only one fossil genus, *Ecphora* Conrad, 1843, which he tentatively placed in Ocenebrinae Cossmann, 1903, because of its paucispiral protoconch, an assignment unequivocally endorsed by Vermiej & Kool (1994). The sarganine protoconch differs from that of rapanine, ocenebrine, and muricine protoconchs illustrated by Kool (1993a, b) in being very low-spired. Paucispiral protoconchs are also present in Pyropsinae (Sohl, 1964), and sarganine protoconchs are similar to those of the pyropsines *Pyropsis* Conrad, 1860, and *Napulus* Stephenson, 1941, in being paucispiral, rapidly expanding, and in becoming carinate after about one and a half whorls. Protoconchs of *Napulus* spp. and relatively high-spired *Pyropsis* spp. are not as flattened as the protoconch of *Sargana stantoni* (Weller, 1907). As pyropsines are included in Muricacea (Ponder & Warén, 1988), the protoconch of sarganines is similar to that of these muricaceans.

Sarganinae, comprising *Sargana* and *Praesargana,* have a paucispiral protoconch, a low spire, a rough-textured ornate shell, a fold on the columella, a very narrow anterior canal, the posterior siphonal notch adjacent to the suture rather than at the shoulder, and a moderate to wide umbilicus with a lacinate carina.

Genus *Praesargana* Saul & Popenoe, 1993

Type species: by original designation *Trophon condoni* White 1889, from the Turonian of northern California.



Figures 2–23

Figures 2–4, 7–9, 12 *Sargana stantoni* (Weller, 1907) hypotypes from LACMIP loc. 10326. 2–3, 7 LACMIP 12331, 2, apical view, ×2; 3, back view, ×1.5; 7, apertural view, ×1.5. 3, 9, 12 LACMIP 12332, 3, back view, ×1; 9, apertural view, ×1.5; 12, labral view, ×2. 8, LACMIP 12333, showing columellar fold, ×2. Figures 5–6, 10–11. *Praesargana* ***argentea*** Saul, sp. nov. all ×1.5. 5–6, 10, holotype, USNM 482399 from USGS loc. 2759; 5, apical view; 6, back view; 10, apertural view; 11, paratype, LACMIP 12324 from LACMIP loc. 16644, latex pull of back view. Figures 13, 17–20. *Praesargana* ***confraga*** Saul, sp. nov. all ×1. 13, 20, paratype LACMIP 12326 from LACMIP loc. 16524; 13, apical view, apparent rib on ramp is a crack formed during depression of the spire; 20, apertural view. 17–19, holotype LACMIP 12325 from CIT loc. 82; 17, apertural view; 18, umbilical view; 19, back view. Figures 14–16, 21–23. *Praesargana* ***kennedyi*** Saul, sp. nov. all ×1. 14, 16, 22, holotype LACMIP 12328 from CIT loc. 1292; 14, apertural view; 16, back view; 22, ablabral view. 15, 23, paratype LACMIP 12329 from CIT 1891; 15, apertural view; 23, apical view. 21, paratype LACMIP 12330 from CIT loc. 80, apical view.

Discussion: *Praesargana* was placed in Sarganidae because of its resemblance to *Sargana* Stephenson, 1923 (Saul & Popenoe, 1993) (Figures 2–4, 7–9, 12). As characteristic of *Praesargana* but not of *Sargana,* Saul & Popenoe (1993) listed: (1) no spiral sulcus at base of whorl; (2) finer, more regular, and not spiny sculpture; (3) smaller, shallower umbilicus; and (4) shorter, straighter, more open siphonal canal. Inclusion of the new species, *P.* ***argentea,*** *P.* ***con-***

fraga, and *P.* ***kennedyi***, in *Praesargana* requires modification of this list of characteristics. The range of sculpture ascribed to *Praesargana* is expanded to include spines at the intersection of axial and spiral components as in *P.* ***argentea*** and spiral sculpture only, without any axial component, as in *P.* ***kennedyi***. The length of the anterior siphon is a specific character. Width and depth of the umbilicus of *Praesargana* also vary by species, and the umbilicus may be as wide and deep as in *Sargana*.

Sargana and *Praesargana* are very similar. *Sargana* has a flatter protoconch. The whorl profile of *Praesargana* is angulate and widest at the shoulder, tapering toward the siphonal neck, rather than globose and abruptly constricted at the neck, as in *Sargana*. The spiral sulcus at the base of the whorl on *Sargana stantoni* is accentuated by spiral rows of spines above and below it. Stephenson (1923, 1952) and Sohl (1964) emphasized the importance of the spiral sulcus as characteristic of *Sargana*. Although on *Praesargana* ***confraga***, a row of spines at the base of the whorl causes the neck to appear more abruptly constricted than in other *Praesargana*, *Praesargana* lacks the abrupt basal constriction and narrow spiral sulcus of *Sargana*.

Praesargana and *Sargana* have thus far been found in different areas. *Sargana stantoni* (Weller, 1907) is from the Campanian to early Maastrichtian (Sohl, 1964) of the Atlantic and Gulf Coasts of North America and *Sargana geversi* (Rennie, 1930) from the Senonian of Pondoland, South Africa (Sohl, 1964; Stephenson, 1941). *Praesargana* is thus far only known from Turonian deposits of the Pacific Slope of North America.

Praesargana ***argentea*** Saul, sp. nov.

(Figures 5–6, 10–11)

Diagnosis: A *Praesargana* with angular whorl profile and four strong spiral cords on the body whorl; suture not overlapping shoulder of previous whorl; varices foliate and forming spines at intersections with cords.

Description: Shell medium-sized, very low-spired; whorls angulate at shoulder, expanding rapidly; ramp barely sloping, concave to flat; suture abutting below shoulder of previous whorl; whorl sides slightly convex, sloping slightly inward from shoulder to anteriormost strong cord then strongly constricted; umbilicus moderately wide. Sculpture of four spinose, strong cords, strongest on shoulder, weakest at base of whorl; spiral cords crossed by about 14 foliate axials, forming spines at intersections with four major cords; shoulder spines strongest, flattened axially, elongate spirally, and bent apexward. Aperture rather quadrate, strongly constricted to form very narrow, bent, anterior siphonal canal; inner lip well demarked, detached from columella at base of body whorl, extending toward outer lip to form very narrow anterior canal; posterior siphonal notch well defined, at suture; outer lip apparently with denticle opposite columellar fold.

Type specimens: Holotype USNM 482399; paratype LACMIP 12324 from LACMIP loc. 16644.

Type locality: USGS loc. 2759, Ladd Canyon, near Silverado Canyon, Santa Ana Mountains, Orange County, California; Ladd Formation, basal Holz Shale Member.

Dimensions: Of holotype, height 21.8 mm; diameter 21.8 mm; spire height 3.6 mm.

Remarks: Description is based on the holotype, USNM 482399, the most complete of four available specimens. The paratype LACMIP 12324 is a rock mold. Some aspects of the sculpture show more clearly on a latex pull from this paratype than on the holotype. Two other poor but identifiable specimens are from LACMIP loc. 16645 and UCLA loc. 4235. The aperture of *P.* ***argentea*** is more angulate than that of *Praesargana condoni* or *Sargana stantoni* (Weller, 1907), especially at the shoulder, where the presence of a spine gives the aperture of *P.* ***argentea*** a more muricidlike aspect. Possibly a more mature specimen might develop a rounder aperture without an apparent siphon at the shoulder. The holotype of *P.* ***argentea*** is, however, larger than most specimens of *S. stantoni* and figured specimens of *S. geversi*, or *S.? tuberculosa* (Stoliczka, 1867). The sculpture of *P.* ***argentea*** differs from that of *P. condoni* and *S. stantoni* in having no spiral sculpture on the ramp and the axial elements and the spiral cords similarly spaced. *Praesargana* ***argentea*** lacks the secondary ribs of *P. condoni* and *S. stantoni* and has larger and fewer spines.

The protoconch is apparently present in the holotype, but the shell material is recrystallized, and no fine details are preserved. The early whorls resemble those of *S. stantoni* in being flattened and angulate. Among the four California *Praesargana* species, the spire of *P.* ***argentea*** is most like that of *S. stantoni* (Figures 3, 4, 7, 9, 12) in having the suture below the spinose shoulder. *Praesargana* ***argentea*** differs from *S. stantoni* in having a higher spire, a more angulate, straighter sided whorl with fewer cords, and no spiral sculpture or spines on the ramp. *Praesargana* ***argentea*** has a higher spire than either *P.* ***confraga*** or *P.* ***kennedyi***. It differs from *P.* ***kennedyi*** in having foliate varices and four rather than two spiral cords. It differs from *P.* ***confraga*** and *P. condoni* in having fewer but stronger foliate varices, fewer but stronger spiral cords, and a whorl profile that is more strongly angulate and broader at the shoulder.

The holotype of *Praesargana* ***argentea*** was found in association with *Anchura (Helicaulax) tricosa* Saul & Popenoe, 1993, as were the two paratypes from the basal Holz Shale Member on the east side of Silverado Creek south of the old Holz Ranch.

Etymology: The specific name is from Latin, *argentum*, silver, and refers to the occurrence of this species in Silverado Canyon.

Praesargana ***confraga*** Saul, sp. nov.

(Figures 13, 17–20)

Diagnosis: A *Praesargana* with subangular whorl profile and four or five spiral cords on the body whorl; no spiral sculpture on ramp; suture overlapping the shoulder of the previous whorl; varices moderately foliate and forming low spines at intersection with cords.

Description: Shell medium-sized, very low-spired, whorl angulate at shoulder, expanding rapidly; ramp slightly sloping and concave; suture overlapping shoulder of previous whorl and forming nodular welt; whorl sides slightly convexly rounded below shoulder, constricted at base to form short, stout siphonal neck; umbilicus deep and moderately wide, bordered by a laciniate carina. Protoconch paucispiral, consisting of about two rapidly expanding whorls, becoming carinate, surrounding an apical dimple. Sculpture of four or five strong spiral cords, strongest on shoulder; spirals crossed by 23–28 foliate varices forming short spines at intersections with major cords. Aperture with posterior sinus and very narrow anterior canal; inner lip well demarked, thick; outer lip unknown.

Type specimens: Holotype LACMIP 12325 from CIT loc. 82; paratype LACMIP 12326 from LACMIP loc. 16524 Santa Ana Mountains; 12327 from LACMIP loc. 10873 (=CIT loc. 454) near Silverado Canyon, Santa Ana Mountains, Orange County, California.

Type locality: CIT loc. 82, south side Silverado Canyon, south of Holz Ranch, Santa Ana Mountains, Orange County, California, Ladd Formation, transition zone between Holz Shale and Baker Canyon Sandstone Members.

Dimensions: Of holotype LACMIP 12325, height 21.4 (lacking part of siphon), diameter about 23 mm, spire height 4.0 mm; of paratypes LACMIP 12326, height 9.8 (incomplete, lacks part of base and anterior siphon), diameter 26 mm, height of spire 3.4 mm (crushed); 12327 height 17.5 (incomplete, lacking anterior siphon), diameter 21 mm (lacking shell), height of spire 3.8 mm.

Remarks: *Presargana* ***confraga*** is described from four specimens. A specimen from CIT 454 is small and quite biangulate, suggesting that young *P.* ***confraga*** were biangulate, broader at the shoulder, and had the anterior angulation at the third spiral. A fifth specimen from CIT loc. 1064 is too poor to provide additional morphologic information. The most complete specimen is the holotype, which lacks the outer lip and part of the anterior canal. Paratype LACMIP 12326 also lacks the outer lip, and the base is broken off at the fourth spiral cord. Both of the other specimens lack most of the shell.

Praesargana ***confraga*** is similar to *P. condoni* in shape and sculpture, but *P.* ***confraga*** has a sharper shoulder, a wider and deeper umbilicus, fewer spiral cords and axial ribs, and spinier sculpture. It lacks spiral sculpture on the ramp. *Praesargana* ***confraga,*** which as an adult has a more rounded whorl and a more constricted base than other California species, has a whorl profile most like that of *S. stantoni.* The spires of these two are quite different, however, because the suture of *P.* ***confraga*** overlaps the shoulder of the earlier whorl rather than abutting below the shoulder spines. The spire of *P.* ***confraga*** also differs from that of *P.* ***argentea,*** which is similar to that of *S. stantoni. Praesargana* ***confraga*** has one more cord than *P.* ***argentea*** and two fewer than most *S. stantoni. Praesargana* ***confraga*** differs from *P.* ***kennedyi*** in having a more rounded shoulder, four or five strong cords rather than two on the body whorl, and varices that are spinose at the cords.

Etymology: The specific name is from Latin, *confragus,* broken, rough, uneven.

Praesargana ***kennedyi*** Saul, sp. nov.

(Figures 14–16, 21–23)

Diagnosis: A *Praesargana* with a very angulate whorl profile emphasized by a strong broad cord at the shoulder and having a second weak to moderately strong cord about 2 mm anterior to the shoulder and no axial varices.

Description: Shell of moderate size, thick, very low-spired; whorls strongly angulate at shoulder, rapidly expanding; ramp flat to barely sloping; suture at or barely below shoulder of previous whorl; whorl sides nearly flat, straightly sloping to siphonal neck; umbilicus deep, narrow. Protoconch paucispiral, consisting of about two rapidly expanding whorls, becoming flatly carinate, surrounding an apical dimple. Sculpture dominated by strong, broad cord at shoulder and lesser broad cord about 2 mm anterior to shoulder; fine axial and spiral threads forming fine cancellate pattern on whorl sides. Aperture roundish, subangulate at shoulder; inner lip thick, detached from columella at base of body whorl, rounding away from penultimate whorl toward outer lip; posterior siphonal notch well defined, at suture; outer lip bearing a strong denticulation at base of whorl opposite fold on columella; anterior siphonal canal very constricted, moderately long and deep.

Type specimens: Holotype LACMIP 12328, paratypes LACMIP 12329 from CIT loc. 1891, paratype LACMIP 12330 from CIT loc. 80.

Type locality: CIT loc. 1292, west side of Ladd Canyon approx. 0.8 km north of Silverado Canyon, Santa Ana Mountains, Orange County, California, Ladd Formation, Baker Canyon sandstone Member.

Dimensions: Of holotype, height 29 mm, diameter 25.4 mm (incomplete), spire height 3.8 mm; paratype 12329, height 20.7 mm (lacking anterior siphon), diameter 26.8 mm, spire height 3.7 mm; paratype 12330, height 14 mm (incomplete, lacking anterior siphon), diameter 24.7 mm, spire height 2.7 mm.

Remarks: Three specimens are assigned to this taxon; all are rather top-shaped and have a strong cord at the shoulder and a lesser, more anterior cord on the whorl flank. The spire varies from nearly flat to convex; sutures abut the shoulder flatly or are slightly stepped; strength of the cords differs between the three specimens. The absence of varices or axial ribs makes this species clearly distinct from other known *Praesargana*. The growth lines are very strong and give the surface a rough aspect. On all available specimens, the posterior portion of the outer lip is broken.

Etymology: The species is named for G. L. Kennedy.

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LOCALITIES CITED

CIT localities have been given LACMIP numbers. Most of the CIT and UCLA localities of the northern Santa Ana Mountains were plotted on Popenoe, 1942: fig. 2, and Saul & Bottjer, 1982: maps 1–3.

80 CIT (= LACMIP 8194): In sandstone above cgl., at fork of Silverado and Ladd Canyons on north side of Silverado Canyon, NW ¼, SW ¼ sec.8, T. 5 S, R. 7 W, El Toro quadrangle Santa Ana Mountains, Orange County, California. Coll: B. N. Moore, 1926. Ladd Formation, Baker Canyon Sandstone Member. Turonian

82 CIT (= LACMIP 8195): Limey sandstone bed near base of shale, south of roadcut at Holz's Ranch (locality may become obscured by slides), Silverado Canyon, east edge of SE ¼, SE ¼, sec.7, T. 5 S, R. 7 W, El Toro quadrangle, Santa Ana Mountains, Orange County, California. Coll: B. N. Moore, 1927 Ladd Formation, Holz-Baker Canyon transition. Turonian.

454 CIT (= LACMIP 10873): Cretaceous shale, fireline about Hough's 80 on south side of stream, about 400′ (?) above creek, Silverado Canyon, 450′S, 875′E of NW cor. sec.16, T. 5 S, R. 7 W, Santiago Peak quadrangle, Santa Ana Mountains, Orange County, California. Coll: B. N. Moore, August, 1929. Ladd Formation, lower Holz Shale Member. Turonian.

1064 CIT (= LACMIP 10893): Area south of Harding Canyon, Vulture Crags, lower part of shale section just north of first large canyon cutting across Cretaceous beds south of Harding Canyon, about 2 mi. S42°E of the dam in Harding Canyon and 6800′ N55°E of juncture of Santiago Creek and Trabuco Canyon Rds., 2600′N, 1625′E of SW cor. sec.34,

T. 5 S, R. 7 W, Santiago Peak quadrangle, Santa Ana Mountains, Orange County, California. Coll: W. P. Popenoe, October 14, 1934. Ladd Formation, lower Holz Shale Member. Turonian.

1292 CIT (= LACMIP 8177): Bluffs at base of Baker Canyon Sandstone, ½ mi. north of Silverado Canyon, west side Ladd Canyon, 1800'S, 600'E of NW cor. sec.8, T. 5 S, R. 7 W, Black Star Canyon quadrangle, Santa Ana Mountains, Orange County, California. Coll: W. P. Popenoe, April, 1936. Ladd Formation, Baker Canyon Sandstone Member, lowermost fossiliferous beds. Turonian.

1891 CIT (= LACMIP 10111): Just south across gully from locality CIT 1290, Holz Ranch Silverado Canyon, about 2675'S, 725'W of NE cor. sec.7, T. 54 S, R. 7 W, Black Star Canyon quadrangle, Santa Ana Mountains, Orange County, California. Coll: W. P. Popenoe, March 1939. Ladd Formation, transitional beds top of Baker Canyon Sandstone or base of Holz Shale Member. Turonian.

2759 USGS: Near Silverado Canyon, in lower part of Ladd Canyon, Santa Ana Mountains, Orange County, California. Coll: S. Bowers, April 24, 1903. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

4235 UCLA: Dip slope of Baker Canyon Sandstone cropping out about 0.3 mi. NW of old Holz Ranch house, 2600'N, 700'W of SE cor. sec.7, T. 5 S, R. 7 W, Black Star Canyon quadrangle, Santa Ana Mountains, Orange County, California. Coll: W. P. Popenoe. Ladd Formation, Baker Canyon Sandstone Member. Late Turonian.

10386 LACMIP: Coon Creek, type locality, 36 inches to 51 inches above base, McNairy County, Tennessee. Coll: H. A. Lowenstam, October 23, 1955. Ripley Formation. Late Campanian, *Nostoceras hyatti* zone.

16524 LACMIP: Santa Ana Mountains (precise locality unknown), Orange County, California. Coll: UCLA summer field student, 1948. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

16644 LACMIP: Silverado Creek, S of Holz Ranch, about 0.15 km S of Silverado Canyon Road, W side of narrows, E side of creek, near W line sec. 8, 0.23 km N of SW cor. sec.8, T. 5 S, R. 7 W, El Toro quadrangle, U.S.G.S., 1968, Santa Ana Mountains, Orange County, California. Coll: W. P. Elder, L. R. Saul, & W. V. Sliter, March 23, 1994. Ladd Formation, basal Holz Shale Member. Turonian.

16645 LACMIP: Silverado Creek S of Holz Ranch, about 90 m N of bend to W, E side of creek near E line of sec.7, 0.225 km N of SE cor. sec.7, T. 5 S, R. 7 W, El Toro quadrangle, U.S.G.S., 1968, Santa Ana Mountains, Orange County, California. Coll: L. R. Saul, March 23, 1994. Ladd Formation, basal Holz Shale Member. Late Turonian.

Note added in proof:

M. G. Harasewych has just written that he has recently dissected preserved specimens of the type species of *Tudicla*, and its anatomy is that of a buccinid.